

PCT

WORLD INTELLECTUAL PROPERTY ORGANIZATION  
International Bureau



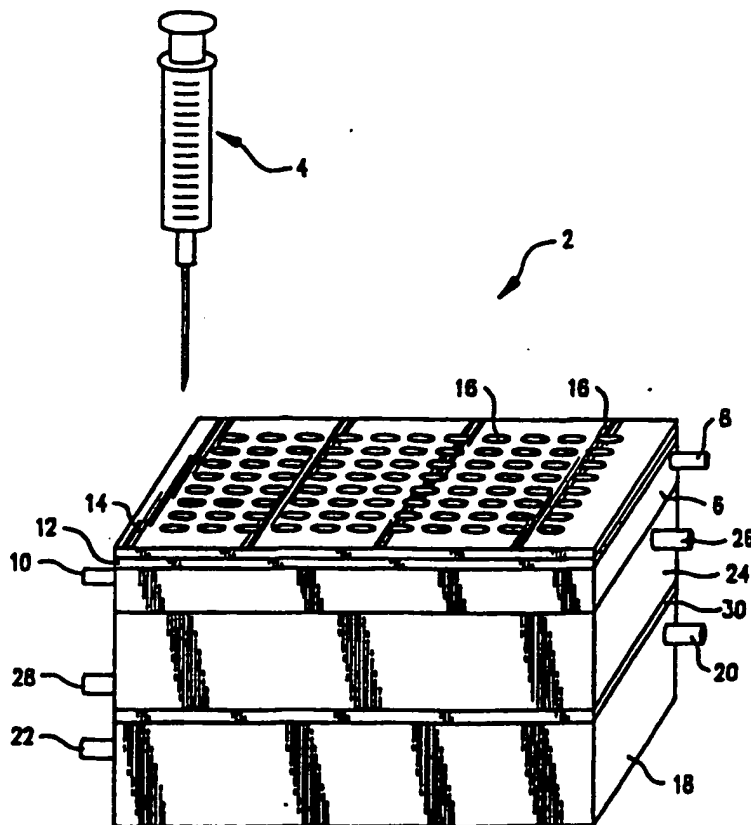
INTERNATIONAL APPLICATION PUBLISHED UNDER THE PATENT COOPERATION TREATY (PCT)

(51) International Patent Classification <sup>6</sup> : C08F 2/00, G01N 21/00, B01L 3/00, C12C 1/00		A1	(11) International Publication Number: <b>WO 97/09353</b>
			(43) International Publication Date: 13 March 1997 (13.03.97)
(21) International Application Number: PCT/US96/14325			(74) Agents: SILBERMAN, Gregory, P. et al.; Graybeal Jackson Haley & Johnson, Suite 2460, 777-108th Avenue N.E., Bellevue, WA 98004-5117 (US).
(22) International Filing Date: 6 September 1996 (06.09.96)			
(30) Priority Data: 08/524,943 7 September 1995 (07.09.95) US			
(60) Parent Application or Grant (63) Related by Continuation US 08/524,943 (CIP) Filed on 7 September 1995 (07.09.95)			
(71) Applicant (for all designated States except US): PATHOGENESIS CORPORATION [US/US]; 201 Elliott Avenue West, Seattle, WA 98119 (US).			
(72) Inventors; and (75) Inventors/Applicants (for US only): BAKER, William, R. [US/US]; 4759-171st Avenue S.E., Bellevue, WA 98006 (US). TOWELL, J., Andrew [US/US]; 1022 W. Crockett, Seattle, WA 98119 (US). HARNESS, James, R. [-US]; 30 Old Mill Grove Road, Lake Zurich, IL 60047 (US).			
(81) Designated States: AL, AM, AT, AU, AZ, BB, BG, BR, BY, CA, CH, CN, CU, CZ, DE, DK, EE, ES, FI, GB, GE, HU, IL, IS, JP, KE, KG, KP, KR, KZ, LC, LK, LR, LS, LT, LU, LV, MD, MG, MK, MN, MW, MX, NO, NZ, PL, PT, RO, RU, SD, SE, SG, SI, SK, TJ, TM, TR, TT, UA, UG, US, UZ, VN, ARIPO patent (KE, LS, MW, SD, SZ, UG), Eurasian patent (AM, AZ, BY, KG, KZ, MD, RU, TJ, TM), European patent (AT, BE, CH, DE, DK, ES, FI, FR, GB, GR, IE, IT, LU, MC, NL, PT, SE), OAPI patent (BF, BJ, CF, CG, CI, CM, GA, GN, ML, MR, NE, SN, TD, TG).			
Published With international search report.			

(54) Title: A DEVICE FOR THE SYNTHESIS OF COMPOUNDS IN AN ARRAY

(57) Abstract

A method and device (2) for the simultaneous production of chemical compounds in an array which is capable of providing a very broad range of reaction environments including reaction temperatures of -40 °C to 150 °C, reflux condensation, and a selective gas environment. The invention also allows the addition of several reagents (4) during the course of the production process. The device (2) is comprised of a number of different block sections (6, 24, 18) which are fastened together to provide the required reaction environment.



**FOR THE PURPOSES OF INFORMATION ONLY**

Codes used to identify States party to the PCT on the front pages of pamphlets publishing international applications under the PCT.

AM	Armenia	GB	United Kingdom	MW	Malawi
AT	Austria	GE	Georgia	MX	Mexico
AU	Australia	GN	Guinea	NE	Niger
BB	Barbados	GR	Greece	NL	Netherlands
BE	Belgium	HU	Hungary	NO	Norway
BF	Burkina Faso	IE	Ireland	NZ	New Zealand
BG	Bulgaria	IT	Italy	PL	Poland
BJ	Benin	JP	Japan	PT	Portugal
BR	Brazil	KE	Kenya	RO	Romania
BY	Belarus	KG	Kyrgyzstan	RU	Russian Federation
CA	Canada	KP	Democratic People's Republic of Korea	SD	Sudan
CF	Central African Republic	KR	Republic of Korea	SE	Sweden
CG	Congo	KZ	Kazakhstan	SG	Singapore
CH	Switzerland	LI	Liechtenstein	SI	Slovenia
CI	Côte d'Ivoire	LK	Sri Lanka	SK	Slovakia
CM	Cameroon	LR	Liberia	SN	Senegal
CN	China	LT	Lithuania	SZ	Swaziland
CS	Czechoslovakia	LU	Luxembourg	TD	Chad
CZ	Czech Republic	LV	Latvia	TG	Togo
DE	Germany	MC	Monaco	TJ	Tajikistan
DK	Denmark	MD	Republic of Moldova	TT	Trinidad and Tobago
EE	Estonia	MG	Madagascar	UA	Ukraine
ES	Spain	ML	Mali	UG	Uganda
FI	Finland	MN	Mongolia	US	United States of America
FR	France	MR	Mauritania	UZ	Uzbekistan
GA	Gabon			VN	Viet Nam

**A DEVICE FOR THE SYNTHESIS OF COMPOUNDS IN AN ARRAY**

5

10

**Field of the Invention**

15       The present invention relates to a device and method for the production of chemical compounds. More specifically the device and method relate to the simultaneous production of chemical compounds in an array.

**Background of the Invention**

20       Numerous methods and apparatus are well known in the prior art for the multiple simultaneous synthesis of peptides and oligonucleotides. However, all of these methods and devices are limited in one way or another in the range of reaction environments they can provide for or the types of reagents they can accommodate in carrying out a chemical process. Some systems  
25       can handle large arrays of reactions and a wide variety of reagents, but only for chemical reactions to be carried out at room temperature. Other systems can either heat or cool an

ongoing reaction, but are unable to provide a reflux condenser to return a portion of the product stream to the chemical process. And still others are unable to provide an oxygen free environment within which to carry out the reaction.

5           One such known methodology is a solid state technique for the synthesis of peptides and oligonucleotides developed by Affymax Technologies N.V. and disclosed in United States Patent No. 5,143,854. The Affymax technique involves sequentially using light to illuminate a plurality of polymer sequences on a  
10       substrate and delivering reaction fluids to the substrate. While undeniably useful, this system is limited to a small number of reactions and produces only trace amounts of product.

          Another method and device for the synthesis of organic compounds is disclosed in Cody et al., United States Patent No.  
15       5,324,483 (Jun. 28, 1994), Apparatus for Multiple Simultaneous Synthesis. The Cody device consists of a reservoir block having a plurality of wells; a plurality of reaction tubes, usually gas dispersion tubes, having filters on their lower end; a holder block, having a plurality of apertures; and a manifold which may  
20       have ports to accommodate the maintenance/introduction of a controlled environment. The top wall has apertures and a detachable plate with identical apertures. While an advancement over the prior art, the Cody apparatus does not easily facilitate the heating, cooling, and reflux of the product as does the  
25       present invention.

### Summary of the Invention

The present invention concerns a method and device for the simultaneous synthesis of organic compounds in an array. It provides a very broad range of reaction environments including, but not limited to reaction temperatures of -40°C to 150°C, reflux condensation, a selective gas environment, and addition of several reagents during the course of reaction. The present invention is uniquely suited to auxiliary processes including rotational shaking, magnetic stirring, sonicating, photochemistry, and robotic automation.

The device of the present invention is most generally referred to as an array synthesis block and is made up of a number of smaller subunits in combination. The various subunits are assembled in a stack depending upon the type of reaction environment required by the desired synthesis. The device includes a retaining block section for holding reaction vessels. The preferred form of the retaining block section also incorporates gas flow channeling for providing a selective gas atmosphere. Usually nitrogen, argon, or some other inert gas is used in order to carry out reactions to the exclusion of oxygen. One or more temperature control block sections are combined with the retaining block section in order to heat and/or cool the reaction vessels. Heating or cooling is accomplished through the use of electrical heating/cooling elements and/or the circulation of a heating/cooling fluid. A reflux control block section required for certain synthesis is combined with the temperature control block section and the retaining block section in a stack in order to provide reflux condensation during reaction. Cooling

gas or liquid is circulated through the reflux control block section. Alternatively, a portion of the of the reflux chamber is filled with a solid coolant such as ice or solid CO<sub>2</sub>. These block sections are fastened together in a stack to form the array synthesis block. Fastening is accomplished by any number of suitable methods such as bolts passing through registering holes in the multiple block sections, clips holding the multiple block sections together, or an exterior bracket that clamps the block sections together as an assembled synthesis block. Once the individual sections of the synthesis block are fastened together the entire unit can be sonicated or fastened onto a rotational shaker.

#### Brief Description of the Drawings

The invention, together with further advantages thereof, may best be understood by reference to the following description taken in conjunction with the accompanying drawings in which:

FIG. 1a is an isometric view of one embodiment of an array synthesis block utilizing a retaining block section, a reflux control block section, and a temperature control block section.

FIG. 1b is an enlarged partial cross-section view of a retaining block section illustrating the use of a needle to add reagents to the reaction vessels while maintaining a selective gas environment.

FIG. 2 is an exploded isometric view of FIG. 1a showing an attached reaction vessel.

FIG. 3a is a top down view of a retaining block section.

FIG. 3b is a partial cross-section view of the retaining plate illustrated in FIG. 3a.

FIG. 4a is an isometric view of an alternative embodiment for a retaining block section.

FIG. 4b is a partial cross-section view of an alternative embodiment for a retaining block section.

FIG. 4c is a top down view of an alternative embodiment of a retaining block section.

FIG. 5a is an isometric view of a reflux control block section, a spacer plate, and a temperature control block section of a multiple array synthesis block.

FIG. 5b is an exploded cross-section view of FIG. 5a

FIG. 6 is an exploded isometric view of an alternative embodiment of a multiple array synthesis block utilizing a splash guard and insulator mounted on top of the temperature control block section.

FIG. 7a is a front orthogonal cross-section view of a preferred embodiment of the synthesis block.

FIG. 7b is a side orthogonal cross-section view of the synthesis block in FIG. 7a.

FIG. 7c is a top orthogonal cross-section view of the synthesis block in FIG. 7a.

FIG. 8a is a top orthogonal view of the sealing plate used in the synthesis block in FIG. 7a.

FIG. 8b is a side orthogonal cross-section view of the sealing plate in FIG. 8a.

FIG. 8c is a front orthogonal cross-section view of the securing plate in FIG. 8a.

FIG. 9a is a top orthogonal view of the securing plate used in the synthesis block in FIG. 7a.

5        FIG. 9b is a side orthogonal cross-section view of the securing plate in FIG. 9a.

FIG. 9c is a front orthogonal cross-section view of the securing plate in FIG. 9a.

10       FIG. 10a is a top orthogonal view of the retaining block used in the synthesis block in FIG. 7a.

FIG. 10b is a side orthogonal cross-section view of the retaining block in FIG. 10a.

FIG. 10c is a front orthogonal cross-section view of the retaining block in FIG. 10a.

15       FIG. 11a is a top orthogonal view of the insert retaining plate used in the synthesis block in FIG. 7a.

FIG. 11b is a side orthogonal cross-section view of the insert retaining plate in FIG. 11a.

20       FIG. 11c is a front orthogonal cross-section view of the insert retaining plate in FIG. 11a.

FIG. 12a is a top orthogonal view of the upper heating and cooling block used in the synthesis block in FIG. 7a.

FIG. 12b is a side orthogonal cross-section view of the upper heating and cooling block in FIG. 12a.

25       FIG. 12c is a front orthogonal cross-section view of the upper heating and cooling block in FIG. 12a.

FIG. 13a is a top orthogonal view of the lower heating and cooling block used in the synthesis block in FIG. 7a.



FIG. 13b is a side orthogonal cross-section view of the lower heating and cooling block in FIG. 13a.

FIG. 13c is a front orthogonal cross-section view of the lower heating and cooling block in FIG. 13a.

5 FIG. 14a is a top orthogonal view of a room temperature frame for use with the synthesis block in FIG. 7a.

FIG. 14b is a side orthogonal cross-section view of the room temperature frame in FIG. 14a.

10 FIG. 14c is a front orthogonal cross-section view of the room temperature frame in FIG. 14a.  
preferred

#### Detailed Description of the Invention

Shown in FIG. 1a is the basic multiple array synthesis block 2 and a needle equipped syringe 4. The basic components  
15 of the synthesis block 2 are: the retaining block section 6 having a retaining block section gas or liquid inlet 8 and in some embodiments a retaining block section gas or liquid outlet 10, a needle penetrable septum 12, a securing plate 14  
20 having in one embodiment an array of apertures 16, a temperature control block section 18 having a fluid inlet 20 and a fluid outlet 22, a reflux control block section 24 having a condensing coolant inlet 26 and a condensing coolant outlet 28, and a spacer plate 30.

Referring to FIG. 1b, the retaining block section 6 has  
25 an array of apertures 38 passing through it. Along the top surface of this block 6 the apertures 38 are covered with a needle penetrable septum 12. This septum 12 is held in place

by a securing plate 14 which has an array of securing plate apertures 16 passing through it and which are in registration with the apertures 38 in the retaining block section 6. The bottom portion of the apertures 38 in the retaining block section 6 are provided with a securing means 34 for fastening the open ends of the reaction vessels 32. Rubber O-rings 35 are placed in apertures 38 between the open ends of the reaction vessels 32 and the top portion of the apertures 38. Reaction vessels 32 are secured in place by mating threads on the lower interior surfaces of the threaded apertures 38 and the outside of top ends of the reaction vessels 32. The vessels 32 are then secured to the synthesis block 2 by screwing them into the lower portion of the apertures 38 in the retaining block section 6 to a depth in which the O-rings compress and form a tight seal between the top of aperture 38 and reaction vessel 32. Alternatively, a clip mechanism can be used to secure the reaction vessels 32 to the retaining block section 6.

The retaining block section 6 also has a series of gas flow channels 36 running through it which interconnect the apertures 38 above the point at which the reaction vessels 32 are secured. These gas flow channels 36 can be beneath the top surface of the retaining block section 6 or they may simply be routed out the top surface. If the channels 36 are routed out of the top surface, then septum 12 and securing plate 14 serve the dual purposes of enclosing the channels 36 and covering the tops of the apertures 38. The retaining block section 6 also has a gas inlet 8 which is generally

connected to a source of gas in order to provide an inert gas environment to the individual vessels 32. Additionally, referring back to FIG 1a, a gas outlet 10 may be provided in the retaining block section 6. Depending upon the fastening means chosen to hold the multiple array synthesis block 2 together, the securing plate, the septum, and the retaining block section may be provided with a series of aligned fastener holes.

FIG. 2 illustrates how the synthesis block 2 is assembled from the component block sections. The array of securing plate apertures 16, retaining block section apertures 38, and the reflux control block section apertures 40 are all in registration. The securing plate apertures 16 each need only be large enough to accommodate a needle. This figure also clearly illustrates how the septum 12 and securing plate 14 cover the open tops of channels 36 and the tops of the apertures 38 in the retaining block section 6. It can also be seen that the top of the temperature control block section 18 is open and that a fluid receiving cavity 42 is formed on the inside and that the closed bottom end of the reaction vessels 32 extend into the temperature control block section 18. One embodiment of the present invention includes a spacer/insulator plate 30 between the temperature control block section 18 and the reflux control block section 24 as illustrated in FIG. 1a.

FIG. 3a shows how the channels 36 are laid out in the retaining block section 6 and illustrates one possible placement of bolts 44 and alignment post holes 46 used in

assembling the synthesis block 2. FIG. 3b illustrates an embodiment of how the channels 36 can be connected to the retaining block gas inlet 8.

FIG. 4a shows an alternative layout for the channels 36 in retaining block section 6 and includes a retaining block gas outlet 10. FIG. 4c illustrates how the alternative network of channels 36 are connected to the retaining block gas inlet 8 and the retaining block gas outlet 10.

Referring to FIG. 5a the reflux control block section 24, the spacer/insulator plate 30, and the temperature control block section 18 are illustrated. FIG. 5b further illustrates that there is a second set of apertures 48 in the bottom of the reflux control block section 24 and that the spacer/insulator plate 30 also has a set of apertures 52 passing through it. A series of rubber O-rings 50 are used to form a seal between temperature control block section 18 and the reflux control block section 24. The bottom edges of apertures 48 and the upper edges of apertures 52 are bevelled to increase the efficacy of the O-rings 50.

FIG. 6 shows an alternate embodiment including spacer/insulator plate 30 and splash guard 54. Splash guard 54 is comprised of three subunits: a splash guard top piece 51, a rubber splash guard gasket 53, and a splash guard base plate 55. All three subunits have an array of apertures in registration with each other and the apertures in spacer/insulator plate 30. The apertures in splash guard gasket 53 are slightly smaller in diameter than the apertures in the splash guard top piece 51 and the splash guard base

plate 55 so as to provide a tight seal around reaction vessels.

#### Construction and Materials

The basic components of the synthesis block 2 can be constructed out of any number of well known materials. Th  
5 only restrictions are that they must be able to withstand the operating temperatures of the device and not react with the reagents and gasses to which the components will be exposed. The retaining block section 6 is preferably made out of  
10 Teflon™, but could alternatively be made from plastic, ceramic or other non-reactive material. In one embodiment the retaining block section 6 is a relatively flat panel having exterior dimensions of 12"x13"x1/2". The needle penetrable septum 12 is preferably made out of a sheet of silicon rubber,  
15 but another type of elastomeric polymer could easily be substituted. In one embodiment the needle penetrable septum 12 has the dimensions of 12"x13"x1/8". The securing plate 14 is preferably made out of aluminum, but could alternatively be made from plastic, ceramic, Teflon™, or another suitable  
20 metal. In one embodiment the securing plate 14 has th dimensions of 12"x13"x1/2". The temperature control block section 18 is preferably made out of aluminum, but could alternatively be made from another metal, plastic, or ceramic. In one embodiment the temperature control block section 18 has  
25 the dimensions of 12"x13"x2.5". The reflux control block section 24 is preferably made out of aluminum, but could alt rnatively be made from plastic, metal, ceramic, or glass.

In one embodiment the reflux control block section 24 has the dimensions of 12"x13"x2.125". The spacer/insulator plate 30 is preferably made out of Teflon, but could alternatively be made from plastic, ceramic, or metal. In one embodiment the  
5 spacer/insulator plate 30 has the dimensions of 12"x13"x1/4". The splash guard 54 has dimensions roughly approximate to those of other components of the device and its top piece 51 and splash guard base plate 55 are preferably made of aluminum, but could alternatively be made from plastic,  
10 ceramic, or some other metal. The reaction vessels 32 are preferably made of glass, but other nonreactive materials could be used including plastic. The reaction vessels come in two sizes with the large vessels measuring approximately 16mm in diameter and 125mm in length and the small vessels  
15 measuring approximately 16mm in diameter and 60mm in length. The larger tubes are used primarily when reflux condensation is called for and the additional length is required to accommodate the reflux control block section 24 and provide additional volume for condensation to form.

20 Assembly of the Generalized Embodiment

The retaining block section 6, septum 12, and securing plate 14 are assembled as shown in FIG. 1b using 12 bolts, 8 bolts evenly spaced around the perimeter of Plate 14 and 4 bolts evenly around the center of plate 14. Rubber O-rings  
25 are placed in each aperture 38 so as to rest against the top of the threaded section. Individual reaction vessels 32 with threaded tops are screwed into apertures 38. The entire

reaction block assembly (retaining block section 6, septum 12, securing plate 14, and reaction vessels 32) is attached to the temperature control block section 18 either directly or in combination with the reflux control block section 24 as shown in FIG. 2. An inert gas hose is connected to the reaction block section 6 using gas inlet port 8. Cooling water inlet and outlet hoses (if applicable) are connected to the reflux block section 24 via condensing coolant inlet 26 and condensing coolant outlet 28. Heating and cooling hoses are attached to the temperature control block section 18 using fluid inlet 20 and fluid outlet 22. The assembled device is placed on an orbital shaker such as the Bohdan Labline orbital shaker (Mundelein, Illinois) for stirring agitation. Inert gas, cooling water (if applicable), and heating or cooling fluid at the desired temperature is applied to the device. The device is now ready to receive solvents, chemical reagents and substrates.

#### Operation of the Generalized Embodiment

The individual reaction vessels 32 are purged with inert gas by inserting a hollow open ended needle through the septum 12 into each reaction vessel 12. Air is removed from the vessel 32 by closing gas outlet 10 and creating a vacuum at gas inlet 8. After the air is removed the vessel 32 is filled with an inert gas such as argon through gas inlet 8.

The next operational step involves the sequential introduction of solvents, chemical reagents, and substrates into the vessels 32 via syringe needle 4.

After the solvents, chemical reagents, and substrates are combined, the orbit shaker is turned on and an appropriate agitation level is selected to insure an even and controlled mixing of the reaction vessel contents. When the reactions are completed, the reaction vessels are brought to room temperature, water is added to the vessels and the desired reaction products are isolated by organic solvent extraction.

Description of the Embodiment Disclosed in Figures 7-14

FIGS. 7a, 7b, and 7c illustrate the preferred embodiment of the inventive reaction synthesis block 2 sitting inside insulating sleeve 3a which is further comprised of insulating sleeve liner 3b and insulating sleeve base 3c.

Synthesis block 2 is comprised of the retaining block section 6 having at least one reaction vessel securing insert 7, an insert retaining plate 9, a retaining block section gas inlet 8 and a retaining block section gas outlet 10, a needle penetrable septum 12, a securing plate 14 having an array of securing plate apertures 16, an upper temperature control block section 18a having a fluid inlet 20a and a fluid outlet 22a, a lower temperature control block section 18b having a fluid inlet 20b and a fluid outlet 22b, upper insulating plate 23a, lower insulating plate 23b.

FIG. 8 illustrates that synthesis block 2 may also include a securing plate 5a and a securing septum 5b. Securing plate 5a is preferably manufactured from aluminum and securing septum 5b is preferably manufactured from a Teflon coated silicone rubber such as 45 Durometer.



FIGS. 9a, 9b, and 9c illustrate securing plate 14 and securing plate apertures 16. Securing plate 14 is preferably constructed out of aluminum. The needle penetrable septum 12 which is held in place by securing plate 14 is preferably manufactured from a Teflon coated silicon rubber such as 45 Durometer.

FIGS. 10a, 10b, and 10c show retaining block section 6 having an array of apertures 38 into which the reaction vessel securing inserts 7 are fitted. Retaining block section 6 is preferably manufactured from Fluorosint 500. The reaction vessel securing inserts 7 have a larger diameter than the diameter at the top of the retaining block apertures 38. The reaction vessel securing inserts 7 have apertures which are in registration with the array of apertures 38 in retaining block section 6. The reaction vessel securing inserts 7 use form fitted Teflon coated O-rings to seal the reaction vessel and external Teflon coated O-ring to seal to the Fluorosint 500 retaining block section 6. A mounting pin is used to prevent rotational slippage and is fitted into the groove in the retaining block apertures 38.

The insert retaining plate 9 is illustrated in FIGS. 11a, 11b, and 11c. Insert retaining plate 9 has a plurality of apertures 11 which are in registration with the array of apertures 38 in the retaining block section 6 and the apertures in the reaction vessel securing inserts 7. Insert retaining plate 9 is preferably manufactured from aluminum.

FIGS. 12a, 12b, and 12c show upper temperature control block section 18a having a fluid inlet 20a and a fluid outlet

22a, a plurality of temperature control block apertures 19a, heating element cavities 21a, heating elements 21b, temperature sensor cavities 23a, and temperature sensors 23b. Upper temperature control block section 18a is also provided with a series of fluid circulating conduits 25a in communication with fluid inlet 20a and fluid outlet 22a. The reaction block 2 is cooled by circulating cooling fluids through the fluid circulating conduits 25a by means of a pump via fluid inlet 20a and fluid outlet 22a.

10 Figs 13a, 13b, and 13c, show a lower temperature control block section 18b having a fluid inlet 20b and a fluid outlet 22b, a plurality of temperature control block round bottomed cylindrical indentations 19b, heating element cavities 21a, heating elements 21b, temperature sensor cavities 23a, and temperature sensors 23b. Lower temperature control block section 18b is also provided with a series of fluid circulating conduits 25b in communication with fluid inlet 20b and fluid outlet 22b. The reaction block 2 is cooled by circulating cooling fluids through the fluid circulating conduits 25b by means of a pump via fluid inlet 20b and fluid outlet 22b.

25 The heating elements, pump/pumps connected to the fluid inlets and outlets, and the temperature sensors in the upper and lower temperature control blocks 18a and 18b can be connected to an electrical control circuit which maintains preprogrammed temperatures in the upper and lower temperature control blocks 18a and 18b.

Upper insulating plate 23a and l w r insulating plate 23b  
ar both pr ferably manufactured from Fluorosint 500. Upper  
insulating plate 23a is also provid d with a series of  
apertures through which reacti n vessels 32 pass through and  
5 depend from into the lower temperature control block section  
18b.

FIGS. 14a, 14b, and 14c illustrate the airframe 56 which  
is comprised of an upper plate 58 provided with aperature 60  
and lip 62, a plurality of supports 64, and a base plate 66.  
10 Airframe 56 is used to hold reaction block 2 while carrying  
out reactions at room temperature or for demonstration  
purposes.

From the foregoing teachings, it can be appreciated by  
one skilled in the art that a new, novel, and nonobvious  
15 method and device for the simultaneous production of chemical  
compounds in an array has been disclosed. It is to be  
understood that numerous alternatives and equivalents will be  
apparent to those of ordinary skill in the art, given the  
teachings herein, such that the present invention is not to be  
20 limited by the foregoing description but only by the appended  
claims.

We claim:

1. A device for the retention of reaction vessels and the synthesis of compounds in an array comprising:

a) a retaining block section having a top surface and a bottom surface and a plurality of apertures communicating between the top surface and the bottom surface of the retaining block section; and

b) a fastener adapted for securing said reaction vessels within said retaining block section so that openings in said reaction vessels communicate with an associated aperture and closed vessel ends depend downward therefrom.

2. The device of claim 1, wherein said retaining block section is provided with a series of channels interconnecting the apertures in the retaining block section above the point at which the reaction vessel is secured.

3. The device of claim 2, wherein said retaining block has a gas inlet connected to said series of channels.

4. The device of claim 3, wherein said device additionally comprises:

c) a solid needle penetrable septum covering the apertures in the top surface of said retention block section above the point at which the channels interconnect the apertures.

5. The device of claim 4, wherein said device additionally comprises:

d) a securing plate disposed above said solid septum and detachably fastening the septum to the top surface of said retention block section, said securing plate having at least one opening in registration with said apertures in the top surface of said retention block section for receiving a needle.

6. The device of claim 5, wherein said device additionally comprises:

e) a temperature control block section having an outer surface, an inner surface, an open top end, and a closed bottom end defining a fluid receiving cavity, said temperature control block section mounted below said retaining block section and receiving said reaction vessels through said open top end so that the downwardly depending closed vessel ends extend below the plane of the open top end and into the fluid receiving cavity.

7. The device of claim 6, wherein said temperature control block section is provided with a fluid inlet and a fluid outlet communicating from the exterior of said temperature control block section and said interior cavity.

8. The device of claim 7, wherein said device additionally comprises:

f) a reflux control block section detachably mounted between said retaining block section and said temperature control block section.

9. The device of claim 8, wherein said reflux control block section is a structure having a top surface and a bottom surface, the structure is formed to provide an interior cavity, and a plurality of apertures are provided to receive a midbody portion of said reaction vessels, between said open upper end and said closed lower end, through the top of said reflux control block section and to allow the bottom ends of said reaction vessels to extend through the bottom surface of said reflux control block section and into said temperature control block section.

10. A device for the retention of a reaction vessel and the synthesis of compounds in an array comprising:

a) a retaining structure having an outside surface defining an interior cavity having an interior surface;

b) a reaction vessel securing structure provided with an aperture in communication with said interior cavity and having a mounting structure for holding the open end of a reaction vessel in communication with said interior cavity;

c) a gas inlet port in communication with said interior cavity; and

d) a chemical injection and withdrawal port in communication with said interior cavity and covered with a solid needle penetrable septum and oriented to accommodate the deposition and withdrawal of material from said reaction vessel.

11. The device of claim 10, wherein said device additionally comprises:

e) a second retaining structure having outside surface defining a second interior cavity having an interior surface;

f) a second reaction vessel securing structure provided with a second aperture in communication with said second interior cavity and having a second mounting structure for holding the open end of a second reaction vessel in communication with said second interior cavity;

g) a second gas inlet port in communication with said second interior cavity; and

h) a second chemical injection and withdrawal port in communication with said second interior cavity and covered with a second solid needle penetrable septum and oriented to accommodate the deposition and withdrawal of material from said reaction vessel.

12. The device of claim 11, wherein said gas inlet port and said second gas inlet port are in communication.

13. The device of claim 12, where in said gas inlet port and said second gas inlet port are connected to a common source of inert gas.

14. The device of claim 13, wherein said chemical injection and withdrawal port and said second chemical injection and withdrawal port are covered with a single solid needle penetrable septum.

15. A method for synthesizing compounds in an array of reaction vessels comprising the steps of:

a) securing from the top an array of reaction vessels having open tops, midbody portions, and closed bottoms;

b) covering the open top of said reaction vessels with a solid needle penetrable septum;

c) flowing inert gas into said reaction vessels in a volume at a pressure sufficient to displace any air present in said reaction vessel;

d) controlling the temperature of the reaction vessels by suspending the bottom end of said reaction vessels in a liquid heating and cooling bath; and

e) depositing reagents necessary to a given synthesis in said reaction vessels through the use of a needle.



16. The method described in claim 15, wherein the step of controlling the temperature of the reaction vessels is additionally comprised of the substep of suspending said midbody portions of said reaction vessels in a gas cooling unit mounted above said liquid heating and cooling bath.

17. The device of claim 5, wherein said device additionally comprises:

a sealing plate disposed above and detachably fastened to said securing plate so as to substantially close off at least one aperture in said securing plate.

18. The device of claim 17, wherein said device additionally comprises:

a sealing septum disposed between said sealing plate and said securing plate and detachably fastened to said sealing plate and said securing plate so as to substantially close off at least one aperture in said securing plate.

19. The device of claim 5, wherein said device additionally comprises:

an air frame having an upper plate that has an aperture through which said retaining plate is passed and is detachably secured to said air frame and at least one support member having a length greater than the longest reaction vessel depending from said retaining plate .

20. The device of claim 19, wherein said support has at least one aperture, whereby air may circulate around any depending reaction vessels.

21. The device of claim 7, wherein said temperature control block is additionally comprised at least one heating element.

22. The device of claim 21, wherein said heating element is an electrical heating element.

23. The device of claim 22, wherein said temperature control block is additionally comprised at least one temperature sensing element.

24. The device of claim 23, wherein said temperature sensing element is an electrical temperature sensing element.

25. The device of claim 7, wherein said device additionally comprising:

an insulating sleeve having a base plate and sidewalls formed to provide an interior cavity into which said reaction block may be securely received and removed and having apertures in registration with said gas inlet and outlet ports and said fluid inlets and outlets.

26. The device of claim 25, wherein said sidewalls are manufactured from a combination of Rohacell and Fluorosint 500.

27. A device for the retention of reaction vessels and the synthesis of compounds in an array comprising:

a retention block having a top surface, a bottom surface, a plurality of apertures between said top surface and said bottom surface in communication with each other through a series of channels in the top surface of said retention block;

at least one reaction vessel securing insert detachably fastened within one of the apertures in said retention block and provided with an aperture in registration with the aperture within which the reaction vessel securing insert is fastened and having a mounting structure for holding the open end of a reaction vessel in communication with said aperture of said retention block;

a gas inlet port in communication with said series of channels;

a gas outlet port in communication with said series of channels;

an insert retaining plate having a plurality of apertures in registration with the apertures in said retention block and the at least one reaction vessel securing insert, wherein the apertures in said insert retaining plate have smaller diameter than the at least one reaction vessel securing insert;

a solid needle penetrable septum covering the apertures in the top surface of said retention block

above the point at which the channels interconnect the apertures; and

a securing plate disposed above said solid non-die penetrable septum and detachably fastening the septum to the top surface of said retention block, said securing plate having at least one aperture in registration with said apertures in the top surface of said retention block for receiving a needle.

28. The device of claim 27, wherein said device additionally comprises:

a sealing plate disposed above and detachably fastened to said securing plate so as to substantially close off at least one aperture in said securing plate.

29. The device of claim 28, wherein said device additionally comprises:

a sealing septum disposed between said sealing plate and said securing plate and detachably fastened to said sealing plate and said securing plate so as to substantially close off at least one aperture in said securing plate.

30. A device for the retention of reaction vessels and the synthesis of compounds in an array comprising:

an upper temperature control block having a top surface, a bottom surface, a plurality of apertures between said top surface and said bottom surface for

receiving reaction vessels, and a series of interconnected fluid circulating conduits;

a heating element disposed within said upper temperature control block;

an upper temperature control block fluid inlet in communication with said fluid circulating conduits; and

an upper temperature control block fluid outlet in communication with said fluid circulating conduits.

31. The device of claim 30, wherein said heating element is an electrical heating element.

32. The device of claim 31, wherein said device additionally comprises:

a temperature sensor disposed within said upper temperature control block.

33. The device of claim 32, wherein said temperature sensor is an electrical temperature sensor.

34. The device of claim 32, wherein said device additionally comprises:

a lower temperature control block having a top surface, a bottom surface, a plurality of cylindrical depressions in the top surface for receiving reaction vessels depending from said upper temperature control block, and a series of interconnected fluid circulating conduits;

a heating element disposed within said upper temperature control block;

a lower temperature control block fluid inlet in communication with said fluid circulating conduits; and

a lower temperature control block fluid outlet in communication with said fluid circulating conduits.

35. The device of claim 34, wherein said heating element is an electrical heating element.

36. The device of claim 35, wherein said device additionally comprises:

a temperature sensor disposed within said upper temperature control block.

37. The device of claim 32, wherein said temperature sensor is an electrical temperature sensor.

38. The device of claim 37, wherein said device additionally comprises:

an upper insulating plate, disposed between said upper temperature control block and said lower temperature control block, having a plurality of apertures in registration with the apertures in said upper temperature control block and the cylindrical depressions in said lower temperature control block.

39. A device for the retention of reaction vessels and the synthesis of compounds in an array comprising:

a retention block having a top surface, a bottom surface, a plurality of apertures between said top surface and said bottom surface in communication with each other through a series of channels in the top surface of said retention block;

at least one reaction vessel securing insert detachably fastened within one of the apertures in said retention block and provided with an aperture in registration with the aperture within which the reaction vessel securing insert is fastened and having a mounting structure for holding the open end of a reaction vessel in communication with said aperture of said retention block;

a gas inlet port in communication with said series of channels;

a gas outlet port in communication with said series of channels;

an insert retaining plate having a plurality of apertures in registration with the apertures in said retention block and the at least one said reaction vessel securing insert, wherein the apertures in said insert retaining plate have smaller diameter than at least one reaction vessel securing insert;

a solid needle penetrable septum covering the apertures in the top surface of said retention block

above the point at which the channels interconnect the apertures; and

a securing plate disposed above said solid needle penetrable septum and detachably fastening the septum to the top surface of said retention block, said securing plate having at least one aperture in registration with said apertures in the top surface of said retention block for receiving a needle.

an upper temperature control block below said insert retaining plate and having a top surface, a bottom surface, a plurality of apertures between said top surface and said bottom surface for receiving reaction vessels depending through apertures in the insert retaining plate, and a series of interconnected fluid circulating conduits;

an electrical heating element disposed within said upper temperature control block;

a fluid inlet in communication with said fluid circulating conduits; and

a fluid outlet in communication with said fluid circulating conduits.

an electrical temperature sensor disposed within said upper temperature control block.

lower temperature control block below said upper temperature control block and having a top surface, a bottom surface, a plurality of cylindrical depressions in the top surface for receiving reaction vessels depending



from said upper temperature control block, and a series of interconnected fluid circulating conduits;

an electrical heating element disposed within said lower temperature control block;

a lower temperature control block fluid inlet in communication with said fluid circulating conduits; and

a lower temperature control block fluid outlet in communication with said fluid circulating conduits.

an electrical temperature sensor disposed within said lower temperature control block.

an upper insulating plate, disposed between said upper temperature control block and said lower temperature control block, having a plurality of apertures in registration with the apertures in said upper temperature control block and the cylindrical depressions in said lower temperature control block.

40. The device of claim 39, wherein said device additionally comprises:

an insulating sleeve having a base plate and sidewalls formed to provide an interior cavity into which said reaction block may be securely received and removed and having apertures in registration with said gas inlet and outlet ports and said fluid inlets and outlets.

41. The device of claim 40, wherein said sidewalls are manufactured from a combination of Rohacell and Fluorosint 500.

42. The device of claim 41, wherein said device additionally comprises:

a lower insulating plate disposed between the bottom surface of said lower temperature control block and said base plate.

43. The device of claim 42, wherein said lower insulating plate is manufactured from Fluorosint 500.

44. The device of claim 39, wherein said device additionally comprises:

a sealing plate disposed above and detachably fastened to said securing plate so as to substantially close off at least one aperture in said securing plate.

45. The device of claim 44, wherein said device additionally comprises:

a sealing septum disposed between said sealing plate and said securing plate and detachably fastened to said sealing plate and said securing plate so as to substantially close off at least one aperture in said securing plate.

46. The device of claim 39, wherein said device additionally comprises:

an air frame having an upper plate that has an aperture through which said retaining plate is passed and is detachably secured to said air frame and at least

one support member having a length greater than the longest reaction vessel depending from said retaining plate.

47. The device of claim 46, wherein said support has at least one aperture, whereby air may circulate around any depending reaction vessels.

FIG. 1a

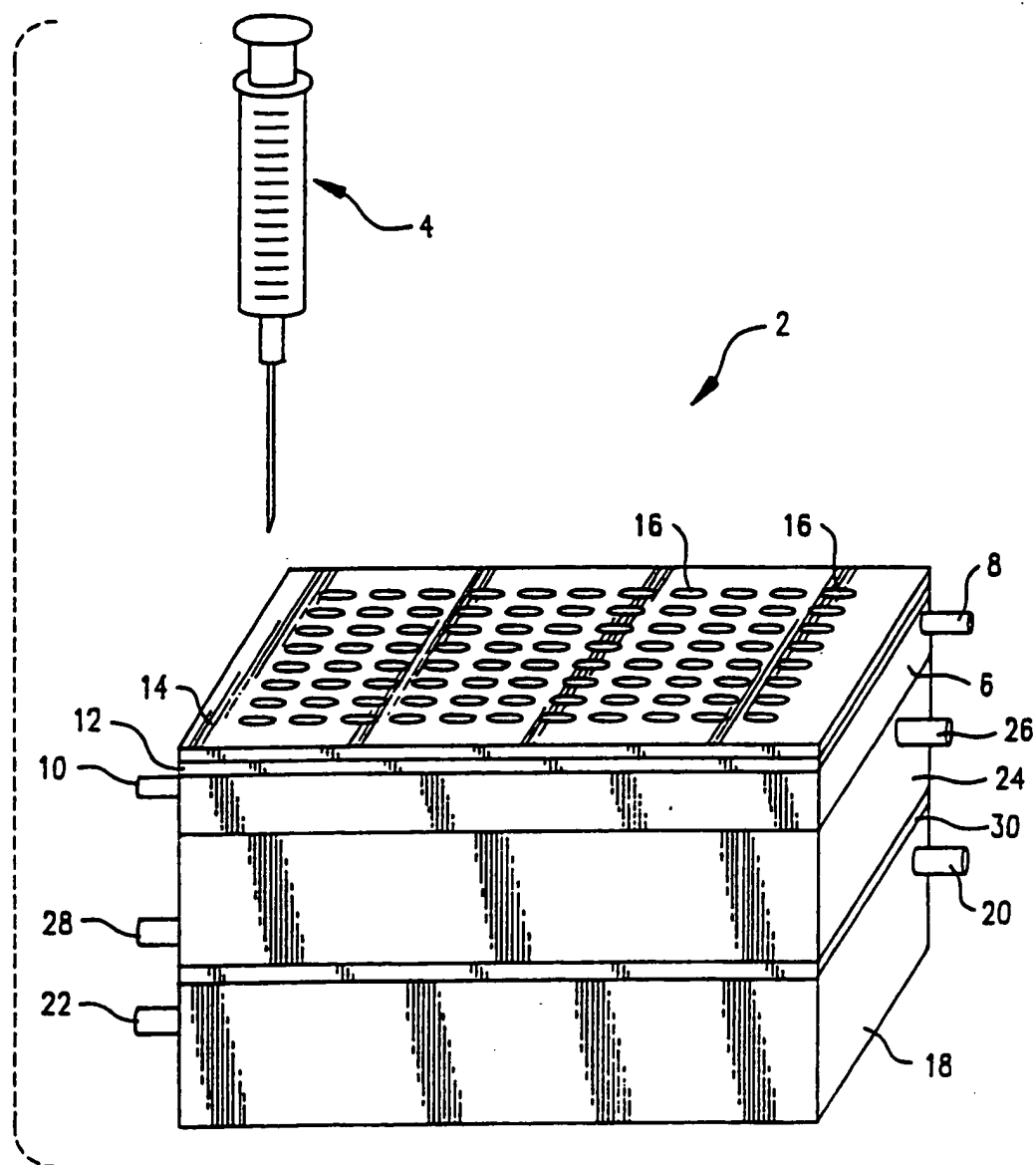


FIG. 1b

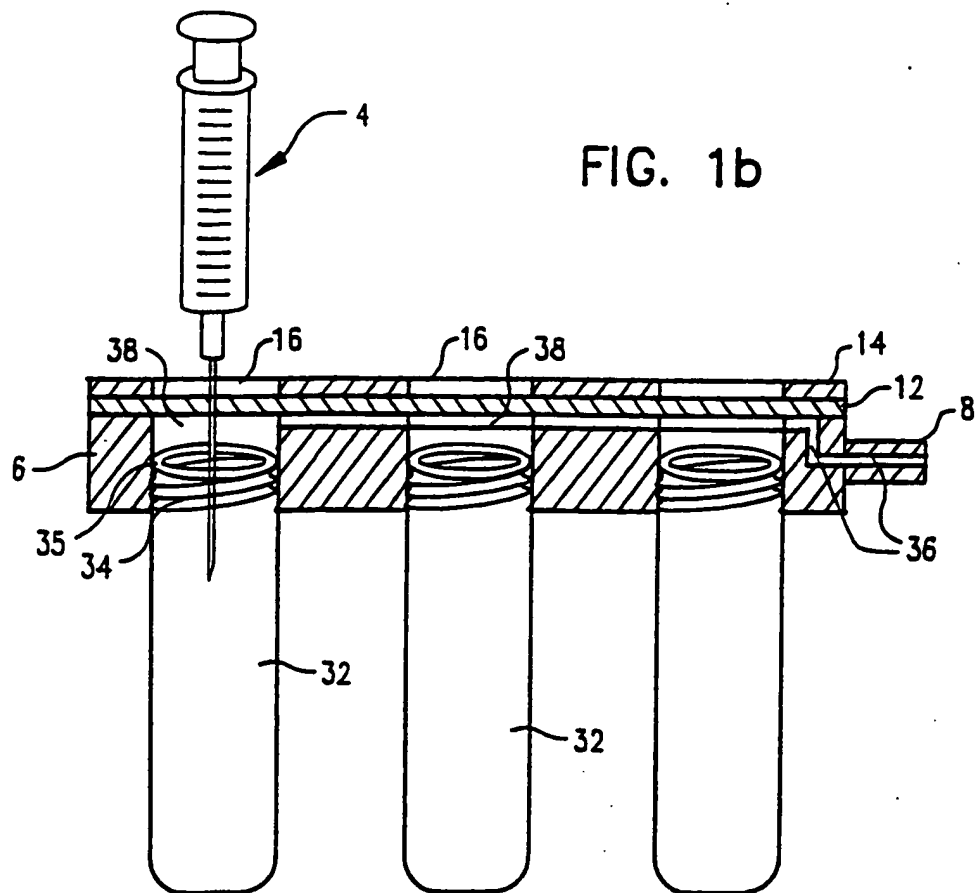
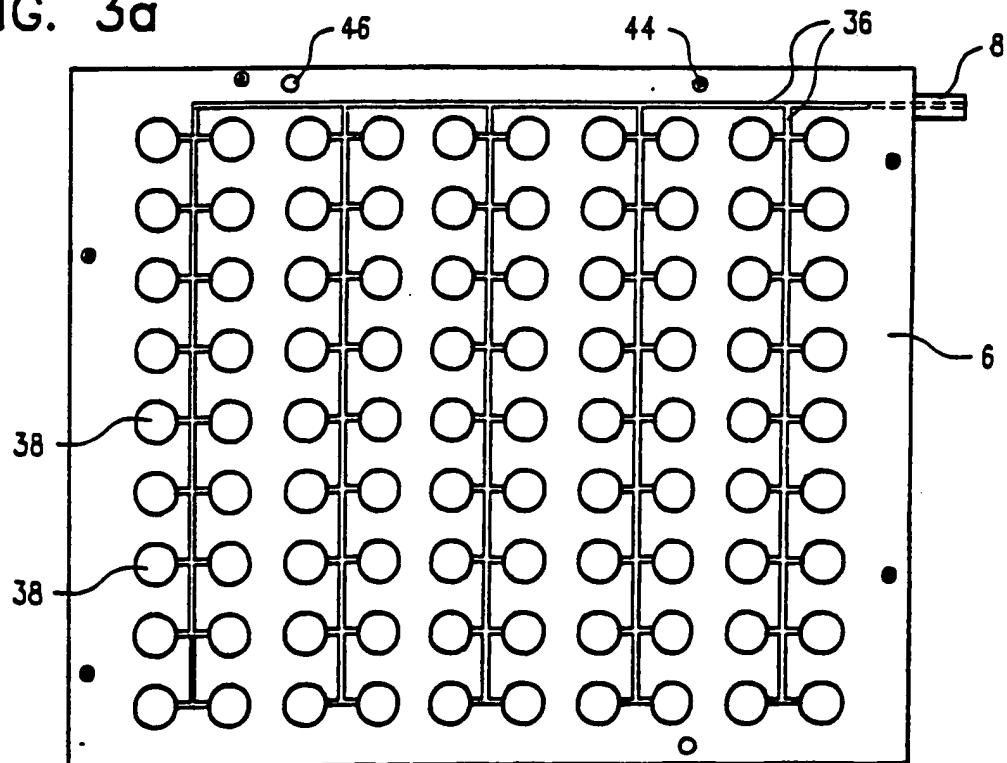
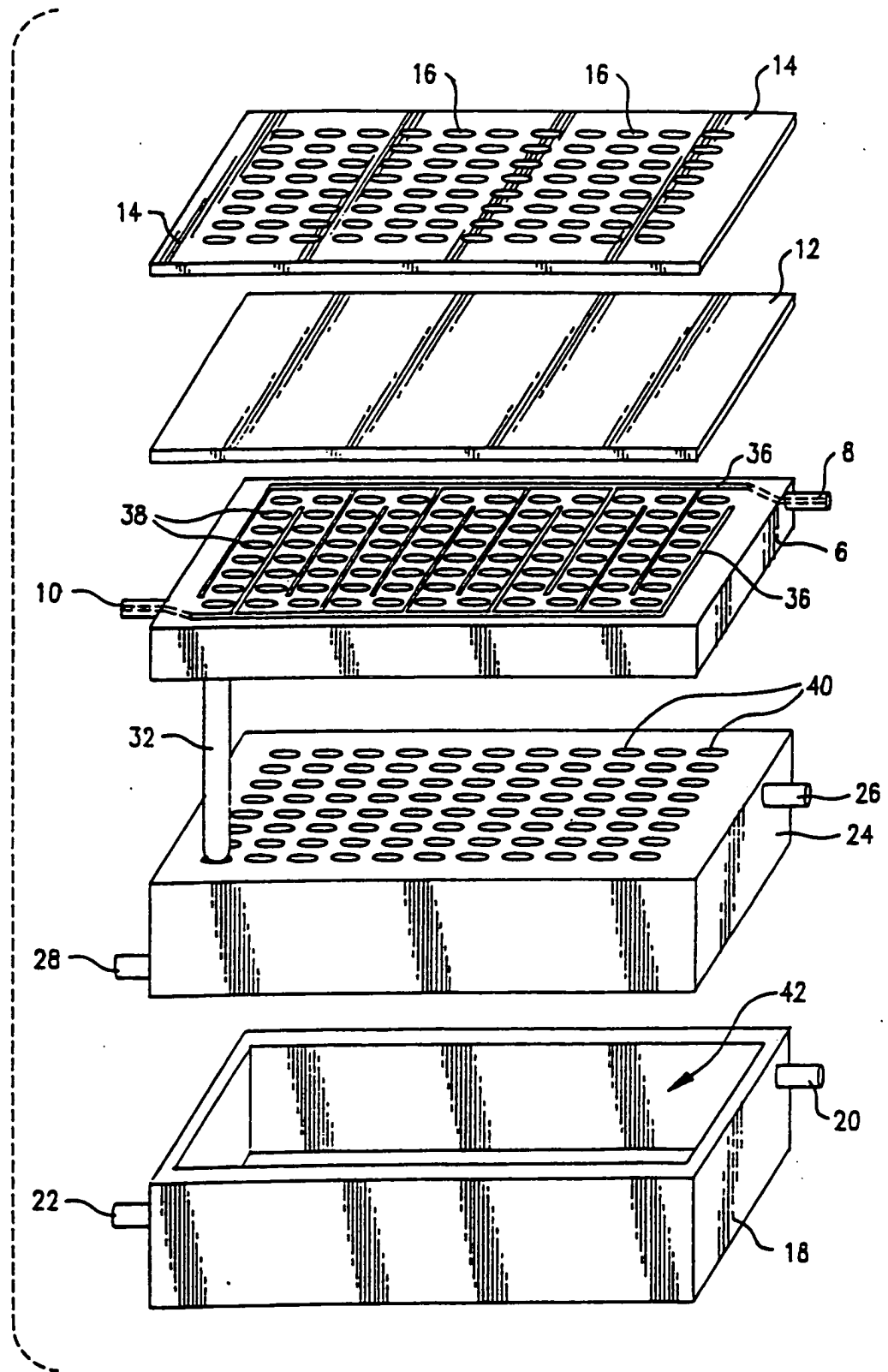


FIG. 3a



3/15

FIG. 2



SUBSTITUTE SHEET (RULE 26)

4/15

FIG. 3b

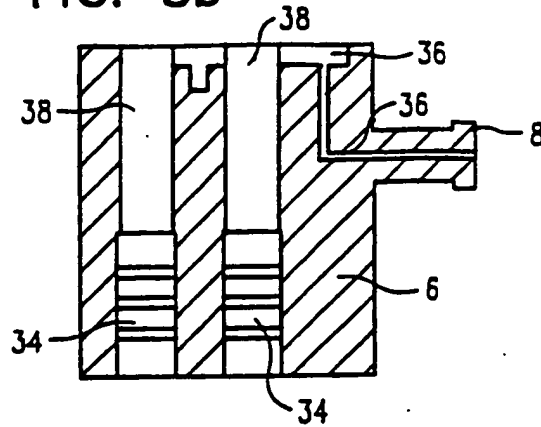


FIG. 4a

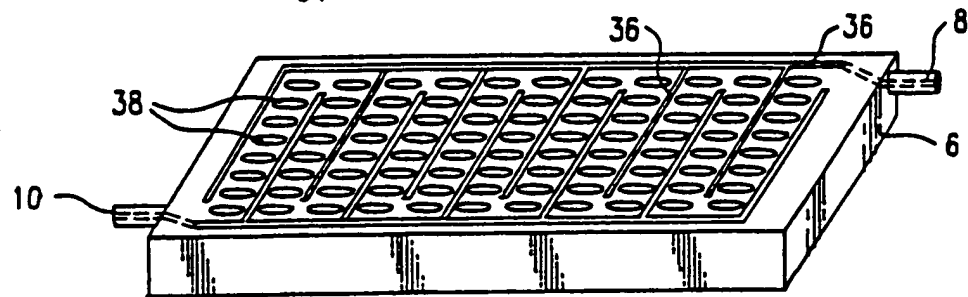


FIG. 4b

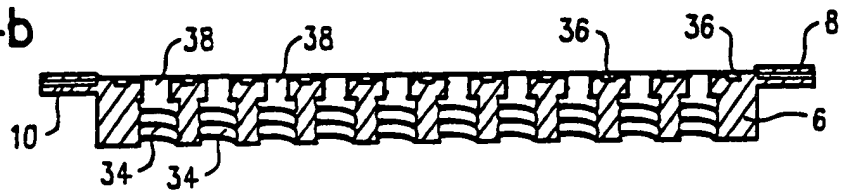
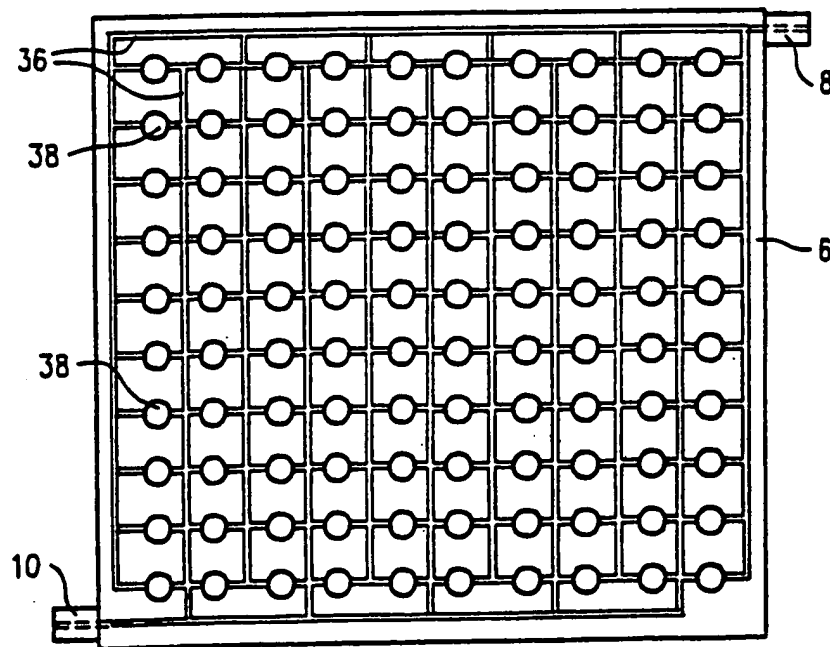


FIG. 4c



SUBSTITUTE SHEET (RULE 26)

5/15

FIG. 5a

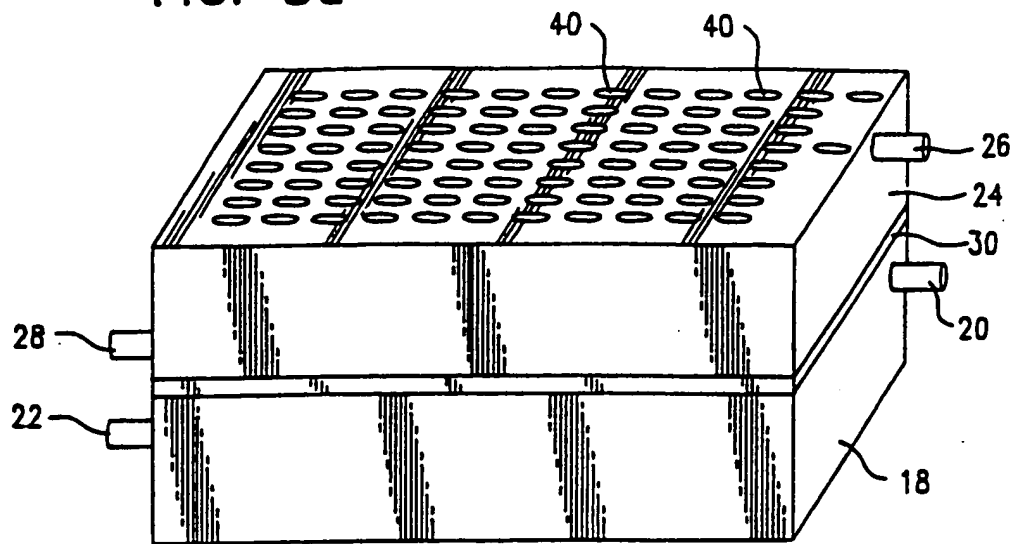
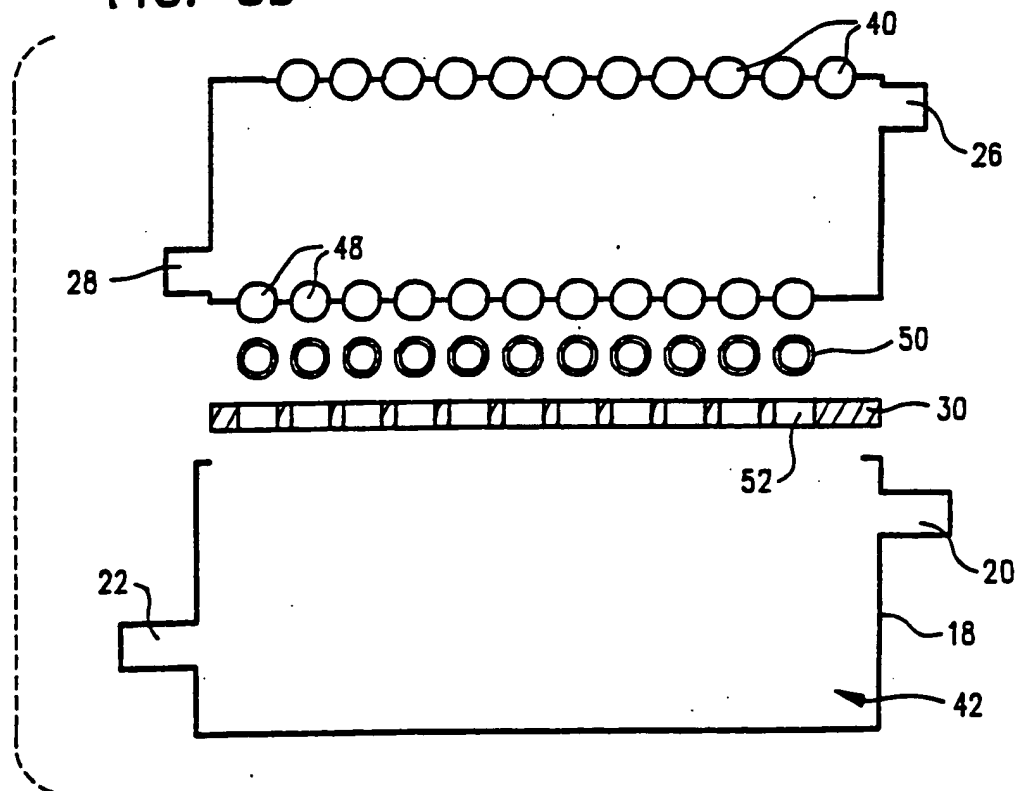


FIG. 5b

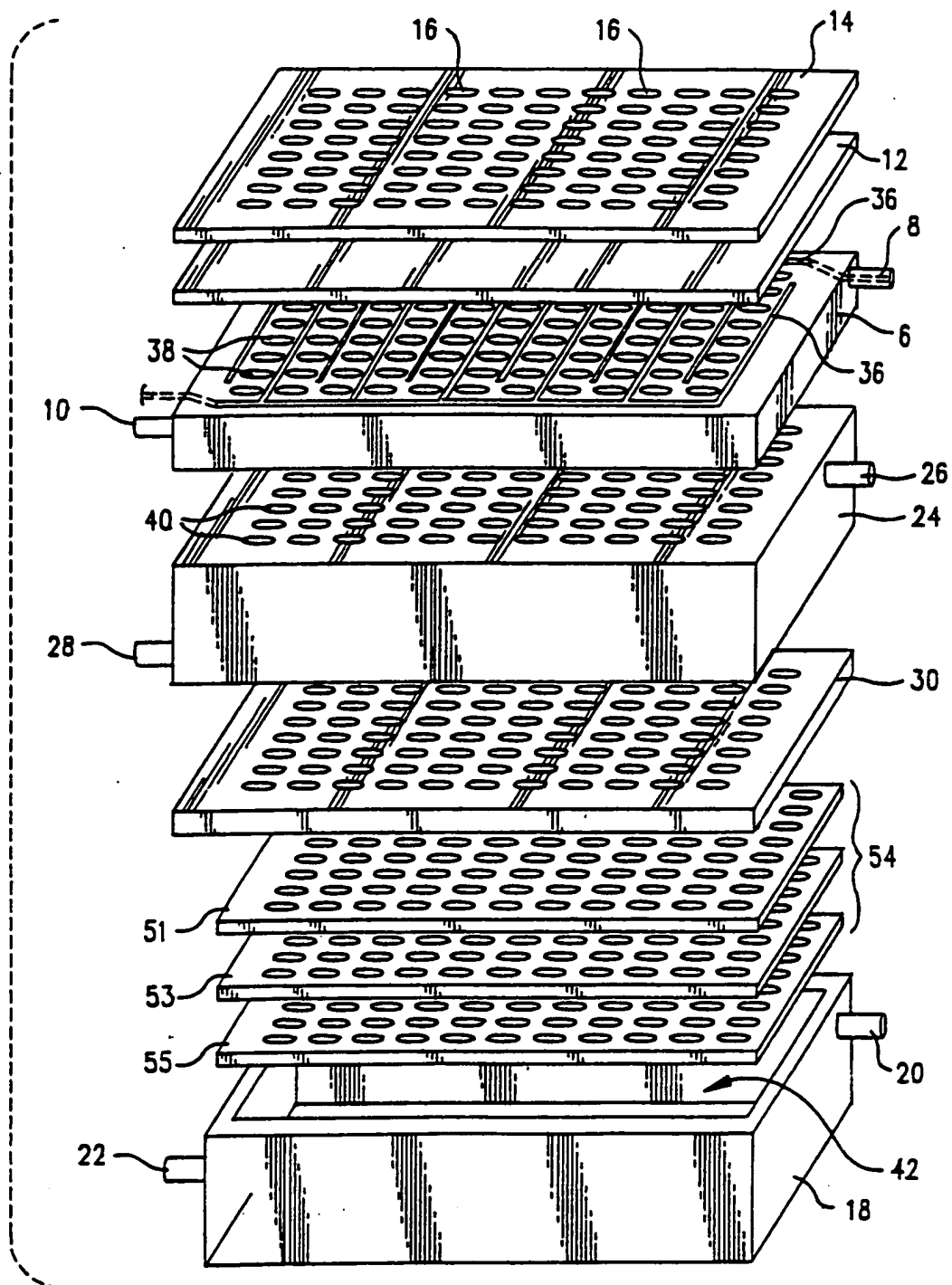


SUBSTITUTE SHEET (RULE 26)



6/15

FIG. 6



SUBSTITUTE SHEET (RULE 26)

7/15

FIG. 7a

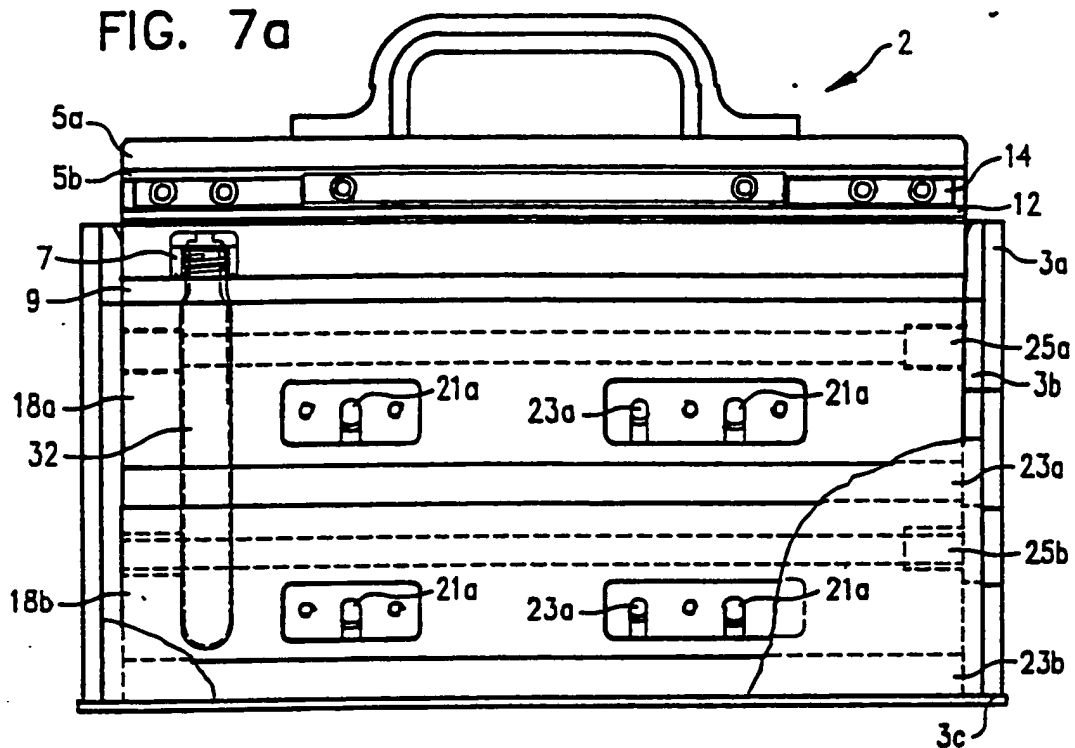
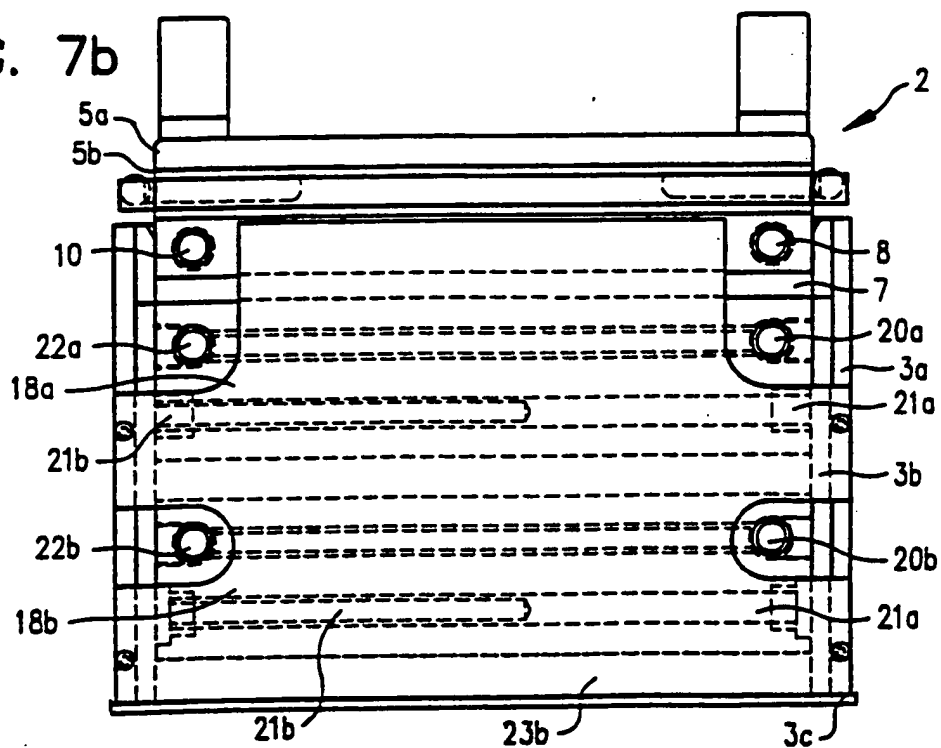


FIG. 7b



SUBSTITUTE SHEET (RULE 26)

8/15

FIG. 7c

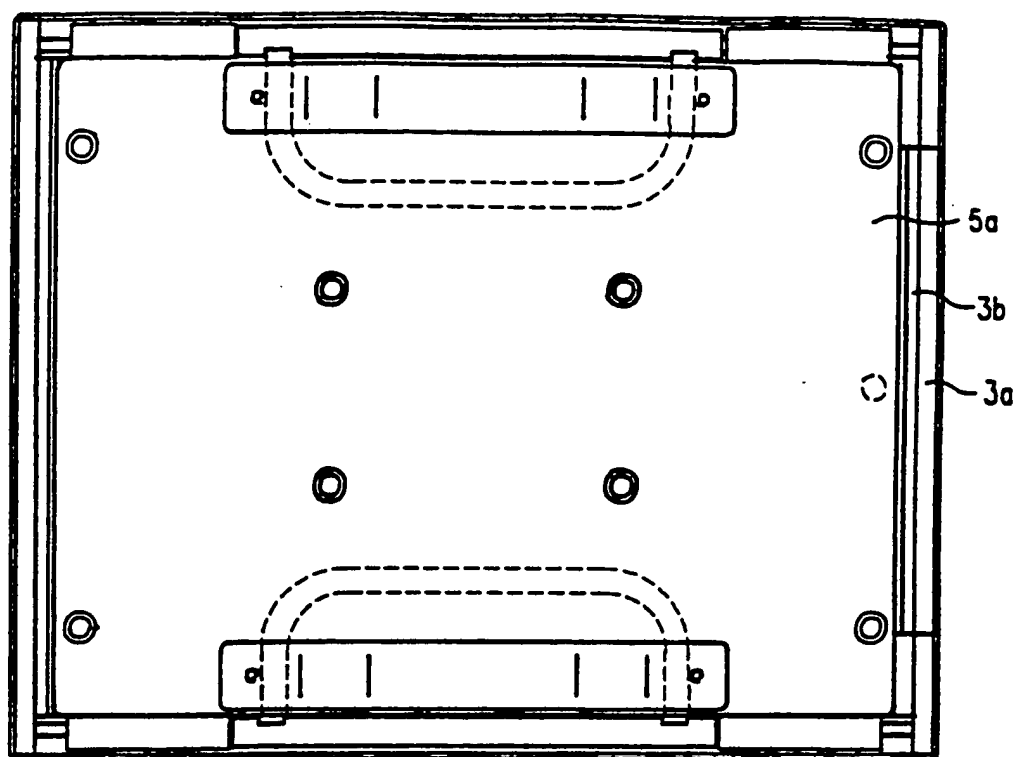
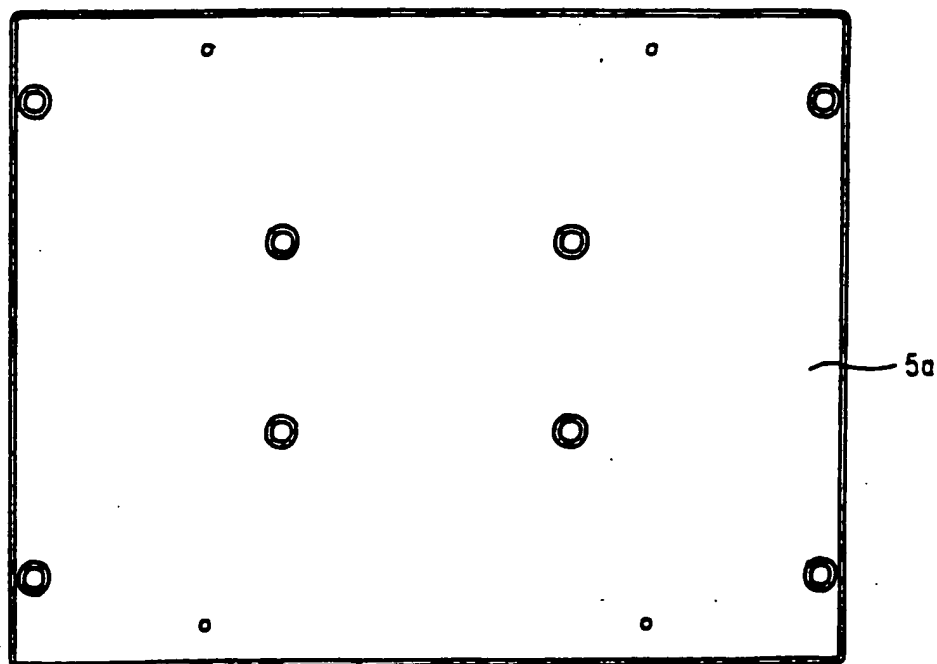


FIG. 8a



SUBSTITUTE SHEET (RULE 26)

9/15

FIG. 8b

FIG. 8c

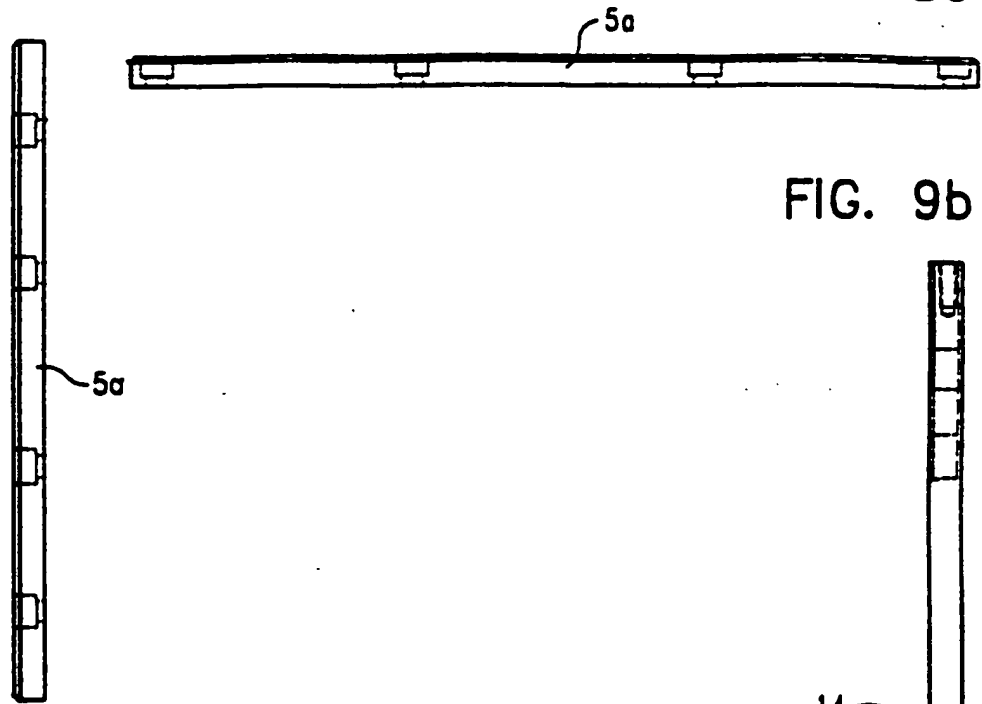


FIG. 9b

FIG. 9a

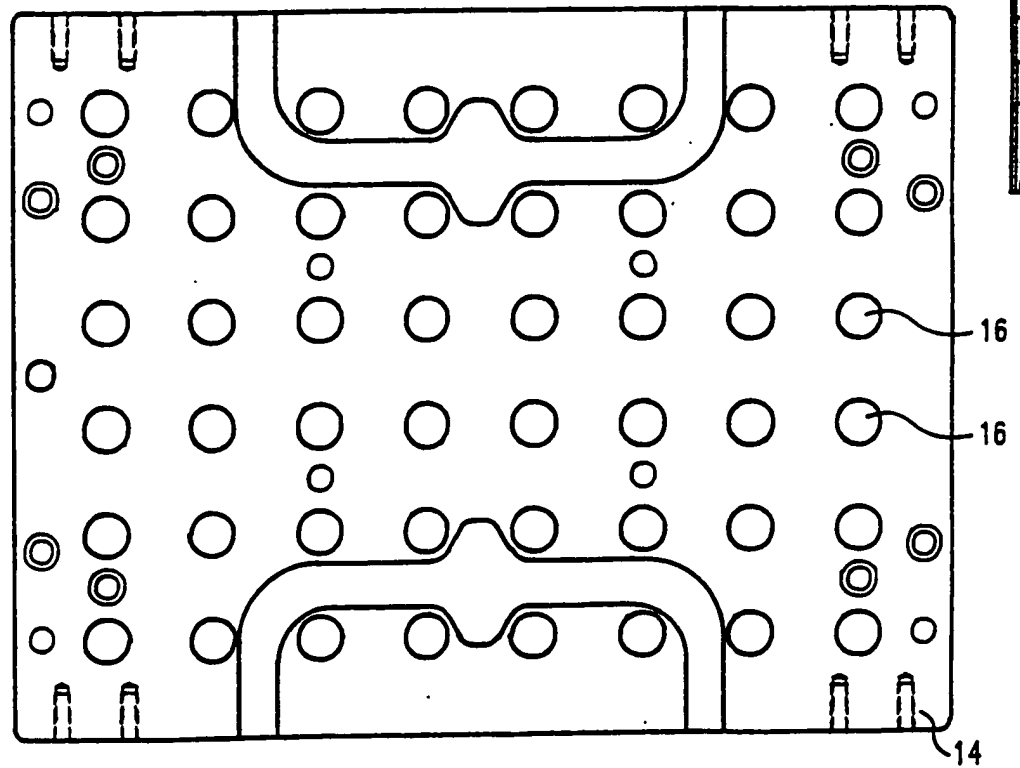
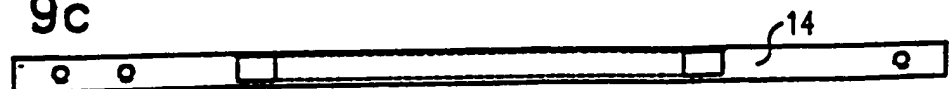


FIG. 9c



SUBSTITUTE SHEET (RULE 26)

10/15

FIG. 10a

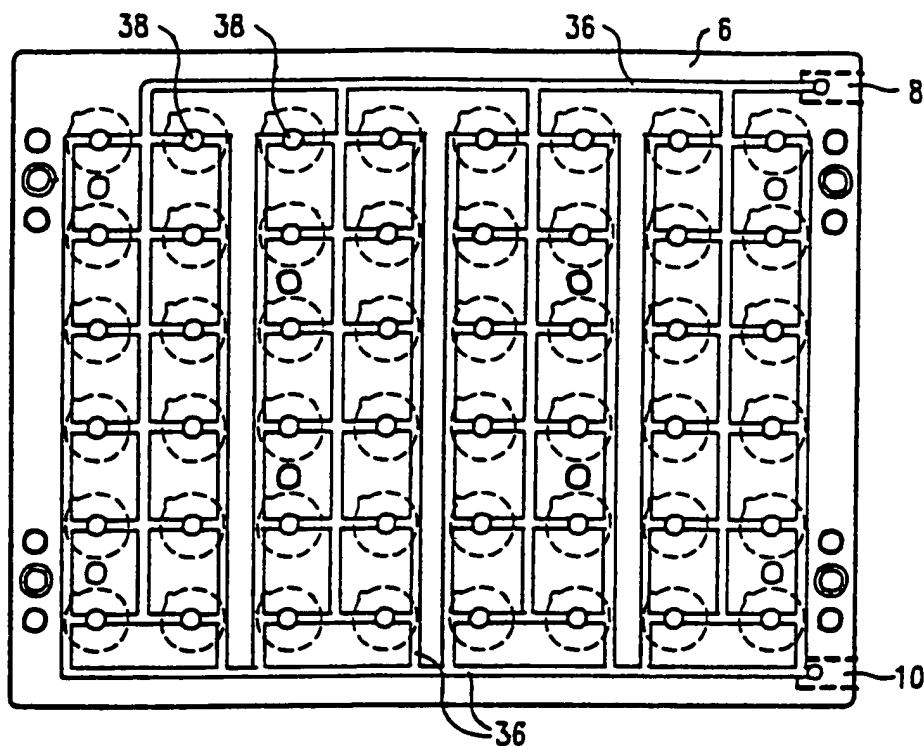


FIG. 10b

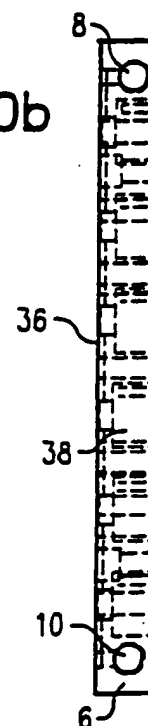
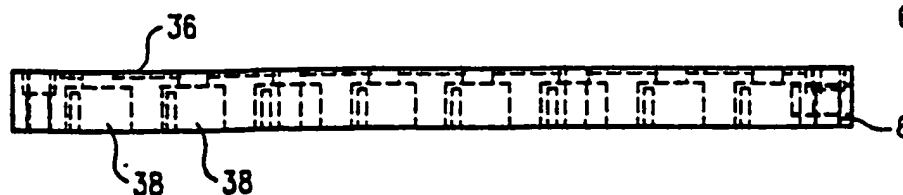


FIG. 10c



SUBSTITUTE SHEET (RULE 26)

11/15

FIG. 11a

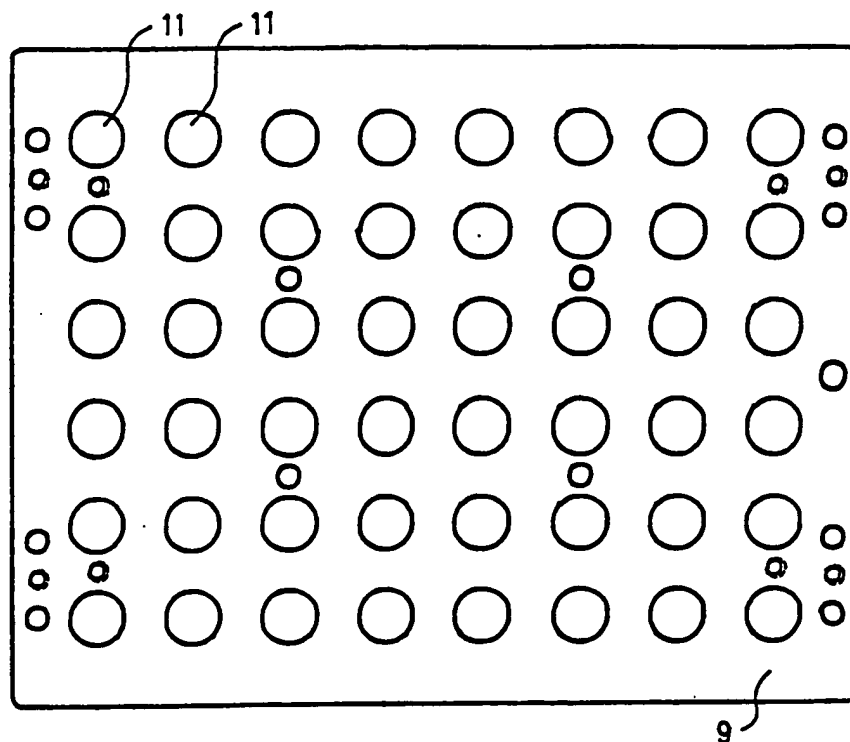


FIG. 11b

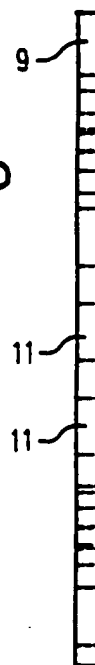
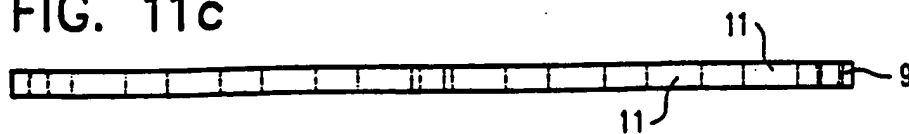


FIG. 11c



12/15

FIG. 12a

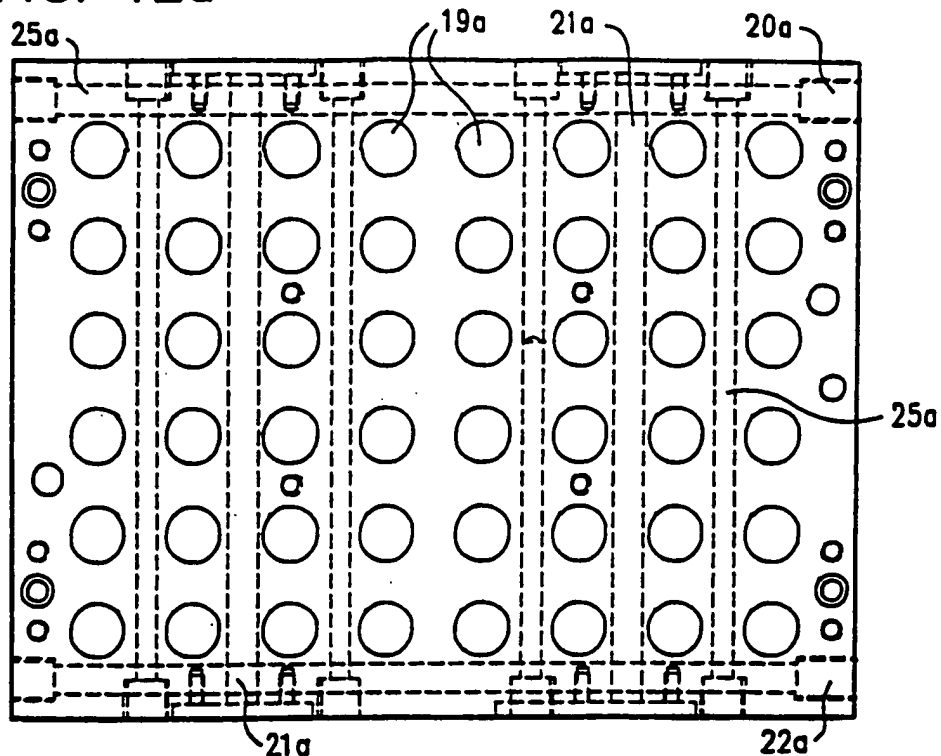


FIG. 12b

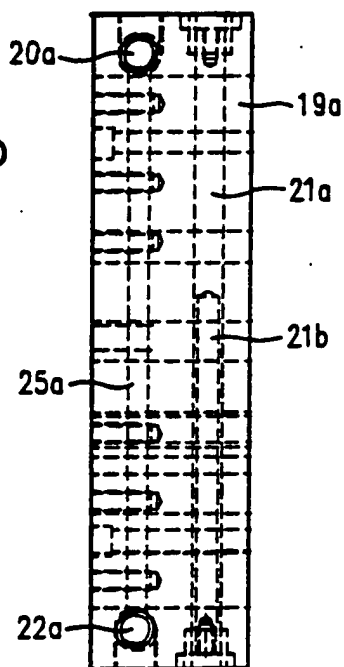
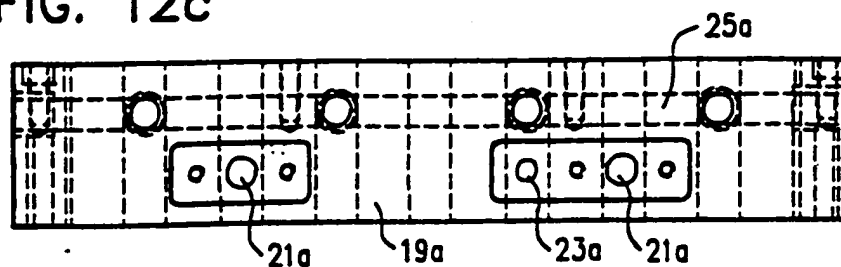


FIG. 12c



13/15

FIG. 13a

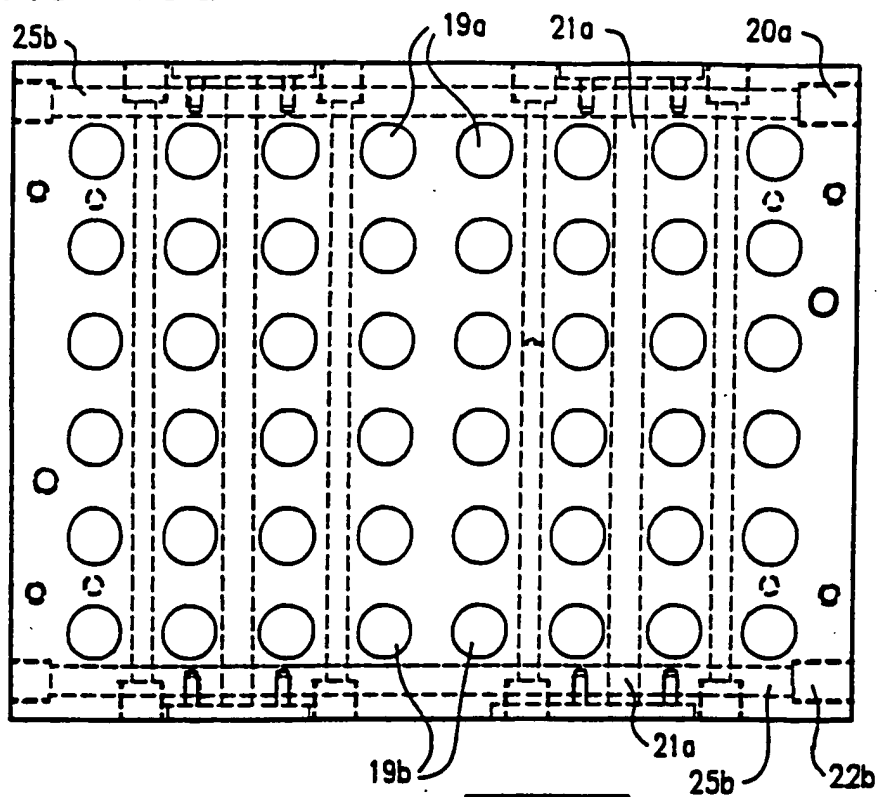


FIG. 13b

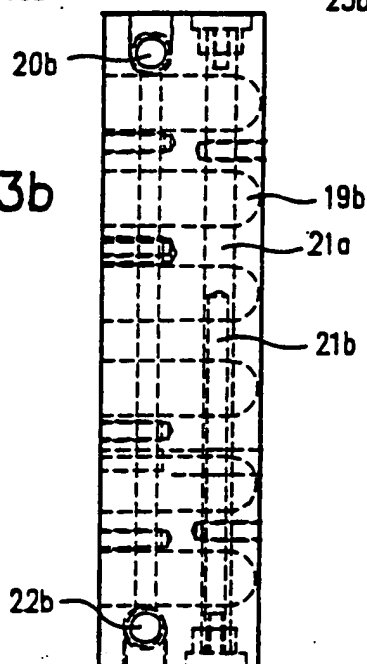
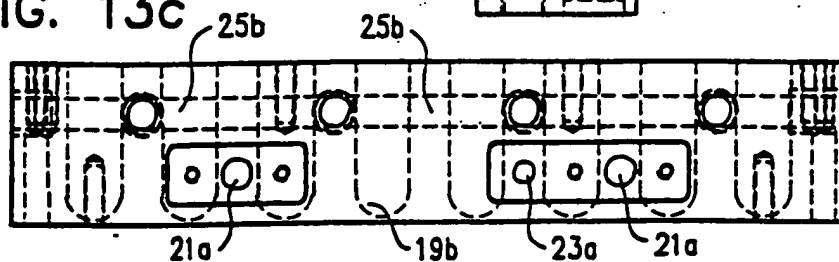


FIG. 13c



SUBSTITUTE SHEET (RULE 26)



14/15

FIG. 14a

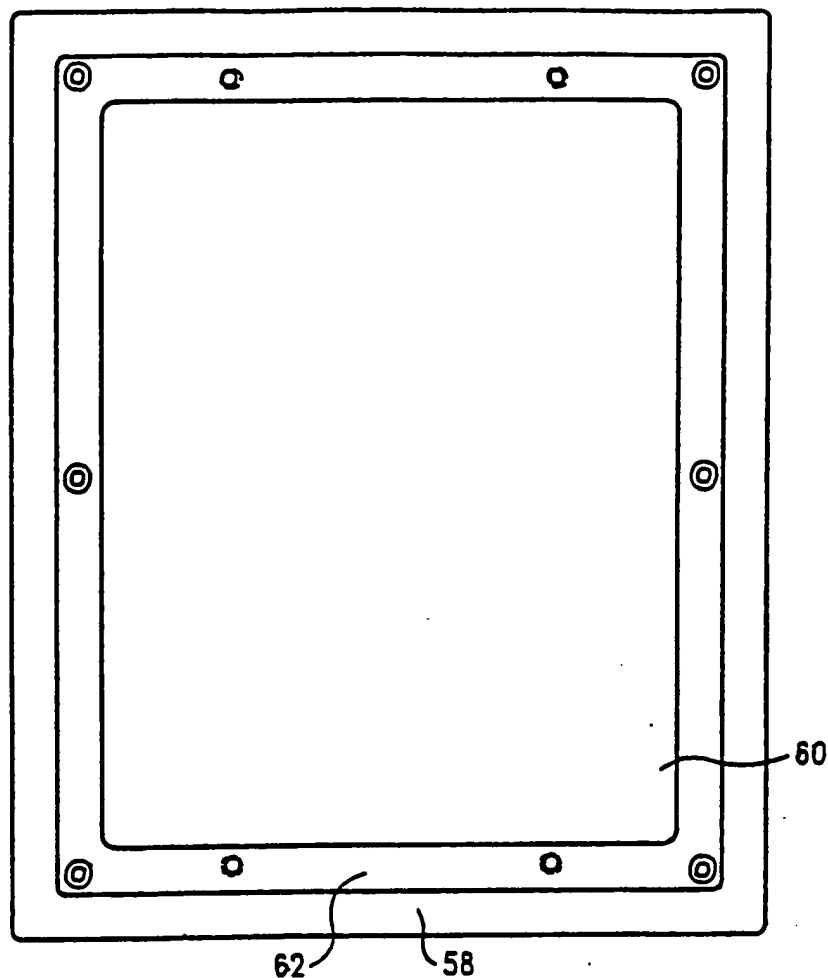
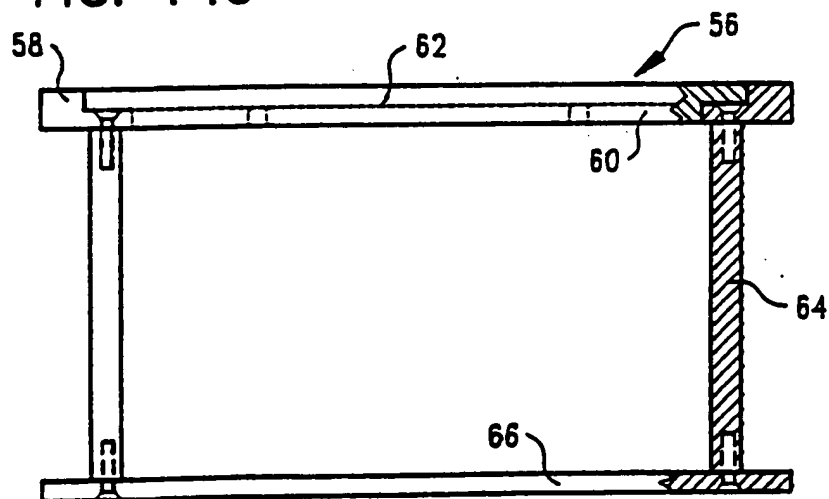


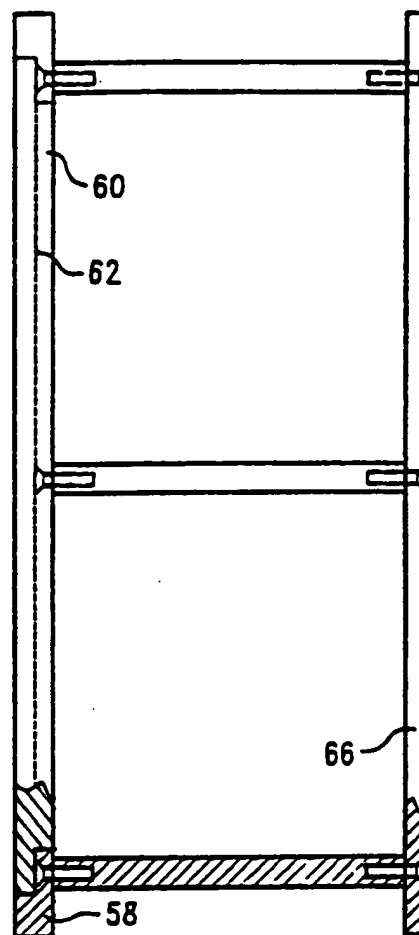
FIG. 14c



CONTINUE SHEET (RULE 26)

15/15

FIG. 14b



SUBSTITUTE SHEET (RULE 26)

## INTERNATIONAL SEARCH REPORT

International application No.

T/US96/14325

**A. CLASSIFICATION OF SUBJECT MATTER**

IPC(6) : C08F 2/00; G01N 21/00; B01L 3/00; C12C 1/00

US CL : 422/131, 81, 99, 102; 435/303.1, 305.1, 305.2, 305.3

According to International Patent Classification (IPC) or to both national classification and IPC

**B. FIELDS SEARCHED**

Minimum documentation searched (classification system followed by classification symbols)

U.S. : 422/131, 81, 99, 102, 297; 435/303.1, 305.1, 305.2, 305.3

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

**C. DOCUMENTS CONSIDERED TO BE RELEVANT**

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	US, A, 5,219,528 (CLARK) 15 June 1993, figure 1.	1
Y		2-47
Y,P	US, A, 5,472,672 (BRENNAN) 05 December 1995, figure 1, column 8.	2-47
Y	US, A, 5,324,483 (CODY ET AL) 28 June 1994, column 10.	4-47
Y	US, A, 4,625,096 (FLETCHER) 25 November 1986, column 1.	6-9
A	US, A, 5,354,663 (CHARM ET AL) 11 October 1994, entire document.	1-47
A	US, A, 5,053,454 (JUDD) 01 October 1991, entire document.	1-47

☒ Further documents are listed in the continuation of Box C.☐ See patent family annex.

* Special categories of cited documents:	"T" later document published after the international filing date or priority date and not in conflict with the application but cited to underlain the principle or theory underlying the invention
"A" document defining the general state of the art which is not considered to be of particular relevance	"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone
"B" earlier document published on or after the international filing date	"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art
"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)	"A" document member of the same patent family
"O" document referring to an oral disclosure, use, exhibition or other means	
"P" document published prior to the international filing date but later than the priority date claimed	

Date of the actual completion of the international search

20 NOVEMBER 1996

Date of mailing of the international search report

24 DEC 1996

Name and mailing address of the ISA/US  
Commissioner of Patents and Trademarks  
Box PCT  
Washington, D.C. 20231

Facsimile N. (703) 305-3230

Authorized filer

CHRISTOPHER KIM

Telephone N. (703) 308-0651

C (Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT		
Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	US, A, 4,526,690 (KIOVSKY ET AL) 02 July 1985, entire document.	1-47
A	US, A, 4,493,815 (FERNWOOD ET AL) 15 January 1985, see entire document.	1-47
A	SYRO II MULTIPLE SYNTHESIS ROBOT brochure.	1-47